We claim:

1) A diffractive structure which applies a specified complex-valued spectral filtering function to an input optical field and which emits a filtered version of the input field in an output direction, said diffractive structure comprising:

a plurality of spatially distinct subgratings,

each subgrating possessing a periodic array of diffraction elements.

2) The structure recited in claim 1 wherein each of said subgratings has an amplitude, spatial phase shift, and spatial period (A_i, x_i , and Λ_i) and a transmissive optical phase shift (φ_i) introduced by a variation in substrate thickness or superimposed phase mask and wherein the amplitude and phase parameters of each of said subgratings is defined in terms of

$$a_i = \beta d \int_{m/(\beta\Lambda)-1/(2\beta d)}^{m/(\beta\Lambda)+1/(2\beta d)} \frac{T(\nu)}{F(\nu)} \exp(-j\pi(\nu\beta - m/\Lambda)(x_i^a + x_i^b))d\nu$$

in the sense that A_i is set by the amplitude of a_i and the phase of a_i sets a combination of x_i and φ_i .

3) An optical structure which applies a specified complex-valued spectral filtering function to the input optical field and which emits a filtered version of the input field in an

output direction said filtered output having a temporal structure essentially matching a reference optical waveform, said structure comprising,

a plurality of subgratings combining to form a segmented grating with a particular transfer function determined by said reference optical waveform.

4) An optical structure which applies a specified complex-valued spectral filtering function to the input optical field and which emits a filtered version of the input field in an output direction said filtered output having a temporal structure essentially matching the cross correlation of the input field with a reference optical waveform, said structure comprising, a plurality of subgratings combining to form a segmented grating with a particular transfer function determined by said reference optical waveform.

5) An optical system for optical code division multiple access (OCDMA) for multiplexing and demultiplexing a plurality of optical signals in accordance with a set of reference optical waveforms, each reference optical waveform comprising a sequence of time slices, said system comprising grating devices each comprising

one or more segmented gratings,

each said segmented grating having a spectral transfer function determined by its constitutive subgrating parameters A_i, φ_i, x_i, and Λ_i that matches a particular reference

optical waveform,

multiplexing multiple optical data streams by directing each onto to a specific segmented grating along its operative input direction thereby producing an output beam encoded according to the reference optical waveform encoded in said specific segmented grating,

demultiplexing a time-code multiplexed optical data stream from a OCDMA channel by directing said OCDMA channel along the operative input direction of a segmented grating encoded so as to direct said time-code multiplexed optical data stream in a time-code specific output direction.

6) The structure recited in claim 1 wherein the spatial placement of the various subgratings is employed to control the spectral transfer function of the structure.

7) The structure recited in claim 1 wherein the amplitude of the various subgratings control the spectral transfer function.

8) The structure recited in claim 1 wherein the optical thickness of the various subgratings comprising the segmented grating is controlled by variation of substrate thickness, addition of segmented phase masks, or other means known in the art to control the spectral transfer function of the segmented grating.

9) The structure recited in claim 1 wherein the addition of active devices as known in the art to dynamically change subgrating optical thickness, phase mask optical

thickness, optical transmission, or placement allow for the dynamical reprogramming of the subgrating parameters and thus the spectral transfer function of the segmented grating.

10) The structure recited in claim 1 wherein the subgratings are transmissive gratings.

11) The structure recited in claim 1 wherein the subgratings are reflective gratings.

12) The structure recited in claim 1 wherein the subgratings comprise a planar suface.

13) The structure recited in claim 1 wherein the subgratings comprise a non-planar surface shaped so as to map the input spatial wavefront onto a desired output spatial wavefront.

14) A method of applying a specified complex-valued spectral filtering function to light in an input optical field by passing said light though a structure which combines plurality of spatially distinct subgratings, each subgrating possessing a periodic array of diffractive elements, said subgratings combining to form a segmented grating with a particular spectral transfer function.

15) A method of applying a specified temporal waveform onto an input optical field by passing said light through a structure which combines a plurality of spatially distinct subgratings, each subgrating possessing a periodic array of diffractive elements, said subgratings combining to form a segmented grating programmed to produce said specified temporal waveform.

16) A method of applying a specified complex-valued spectral filtering function to light in an input optical field by passing said light through a structure which combines a plurality of spatially distinct subgratings, each subgrating possessing a periodic array of diffractive elements, said subgratings combining to form a segmented grating with a particular transfer function that is given by the complex-conjugate of the Fourier spectrum of an reference optical waveform, whereby the light emitted by said structure in a particular direction has a temporal structure given by the cross-correlation of said reference optical waveform and the input optical field.